June, 13th 2007
Landsat Science Team Meeting

Estimating Forest Height & Biomass using the Geoscience Laser Altimeter System (GLAS)

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Warren Cohen – U.S. Forest Service
Michael Lefsky – Colorado State University
Robert Kennedy – U.S. Forest Service

2| Objective

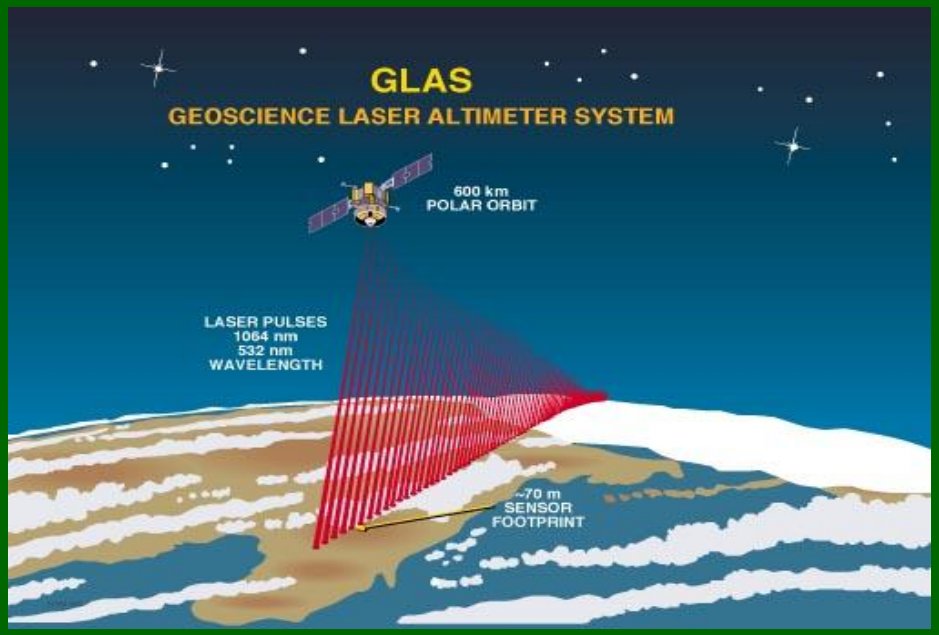


Image credit: NASA

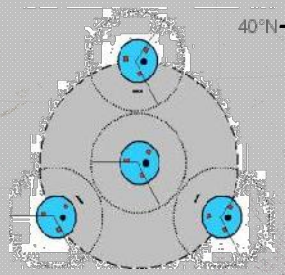
Investigate LIDAR waveforms from the GLAS sensor to provide estimates of forest height and biomass in two pilot study areas in the Western and Eastern U.S.

3| Approach

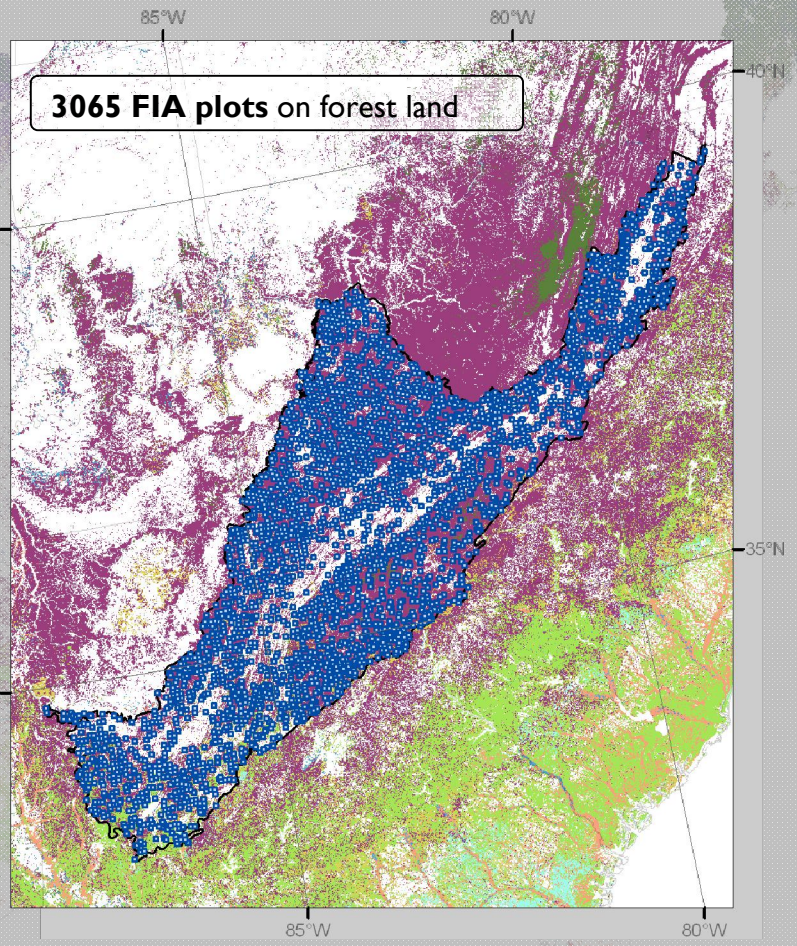
1. Height estimation
   - Development of algorithms for vegetation heights using GLAS waveforms with coincident field data (CSU)
   - Evaluate region of applicability of height algorithms with regional distributions of Forest Inventory samples (PNW-OSU)

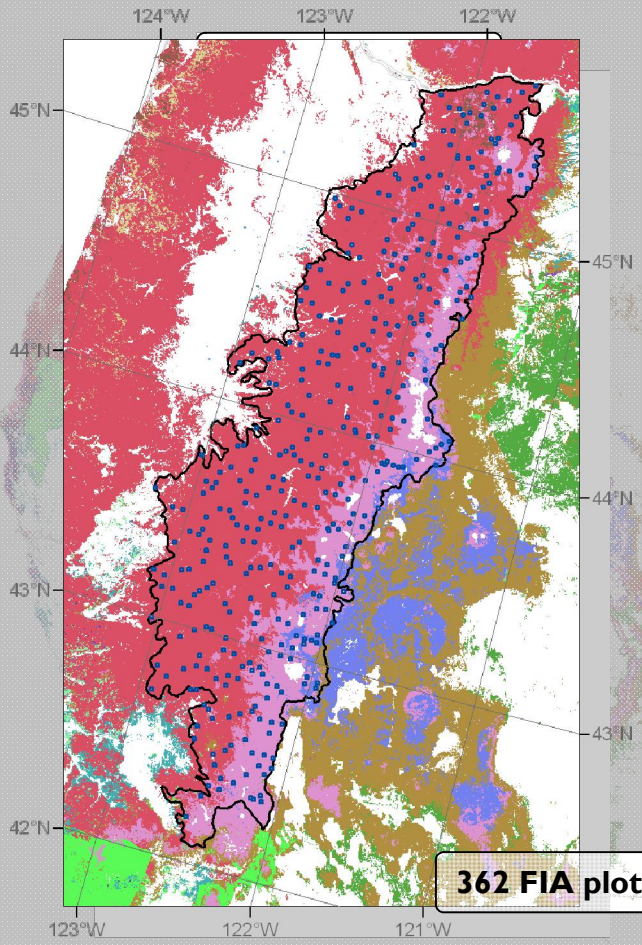
2. Biomass estimation
   - Develop regression models to predict aboveground biomass from stand height using FIA data (PNW-OSU)
   - Compare population estimates from GLAS and FIA (PNW-OSU)

4| Forest Inventory Data



Appalachians



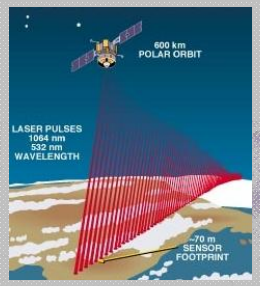


U.S. Forest Type Groups

- Alder/Maple Group
- Aspen/Birch Group
- California Mixed Conifer Group
- Douglas-fir Group
- Elm/Ash/Cottonwood Group
- Exotic Hardwoods Group
- Exotic Softwoods Group
- Fir/Spruce/Mountain Hemlock Grou
- Hemlock/Sitka Spruce Group
- Loblolly/Shortleaf Pine Group
- Lodgepole Pine Group
- Longleaf/Slash Pine Group
- Maple/Beech/Birch Group
- Oak/Gum/Cypress Group
- Oak/Hickory Group
- Oak/Pine Group
- Other Western Hardwoods Group
- Other Western Softwoods Group
- Pinyon/Juniper Group
- Ponderosa Pine Group
- Redwood Group
- Spruce/Fir Group
- Tanoak/Laurel Group
- Tropical Hardwoods Group
- Western Larch Group
- Western Oak Group
- Western White Pine Group
- White/Red/Jack Pine Group

0 20 40 80 Kilometers

5| GLAS data



18,503 GLAS samples on forest land

Appalachians

26,137 GLAS samples on forest land

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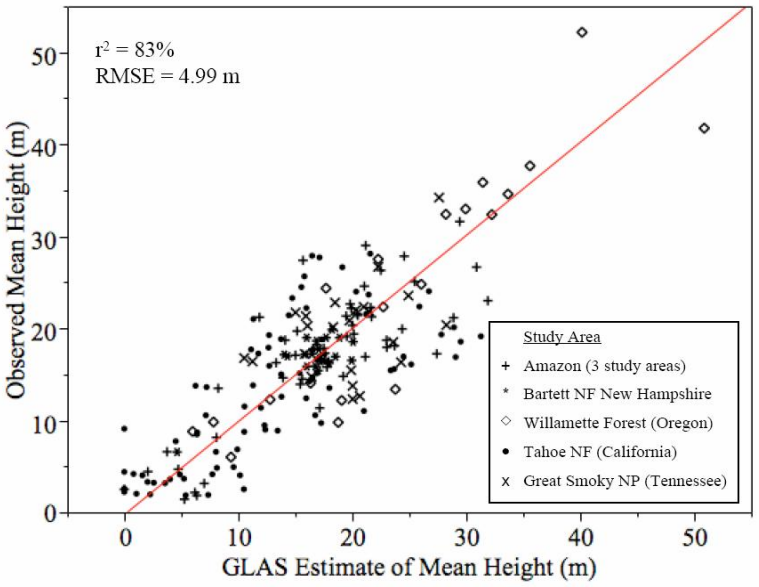
0 20 40 80 Kilometers

6| Height estimation

Performance on height algorithm at coincident field plots



Lefsky et al. (forthcoming)

GLAS waveform schematic

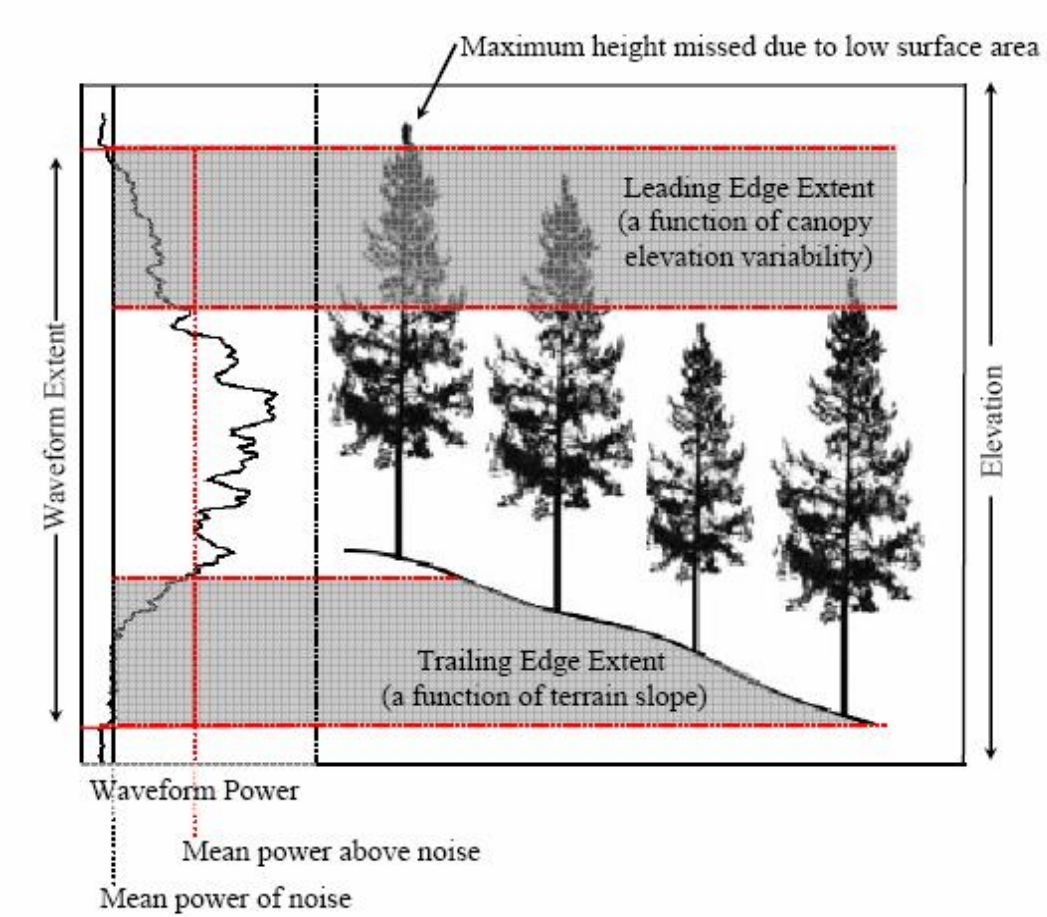
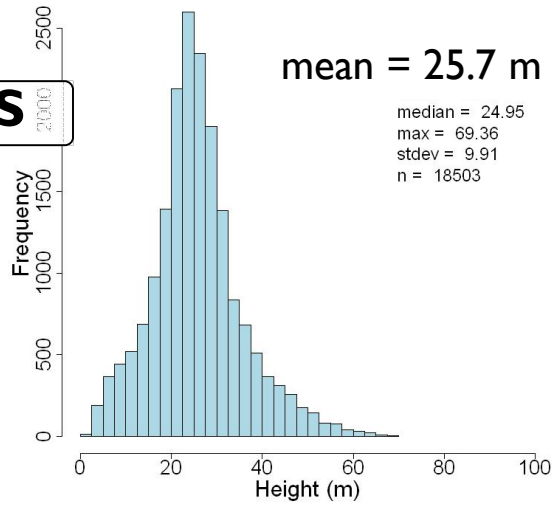


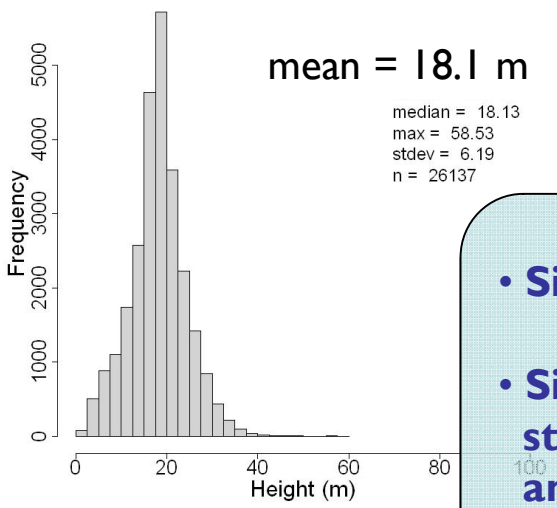
Image courtesy M. Lefsky

7| GLAS & FIA heights of dominant\co-dominant trees

Cascades | **Appalachians**

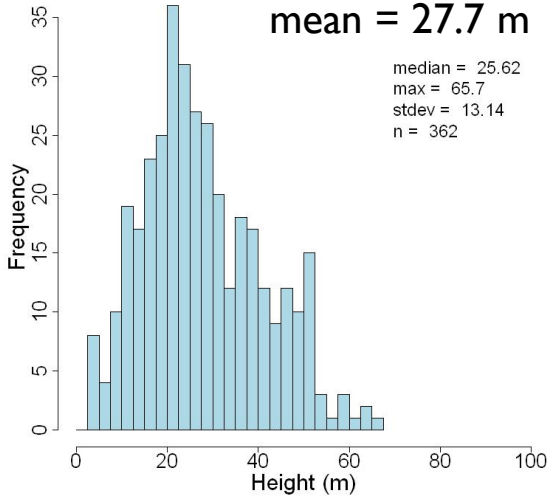
GLAS

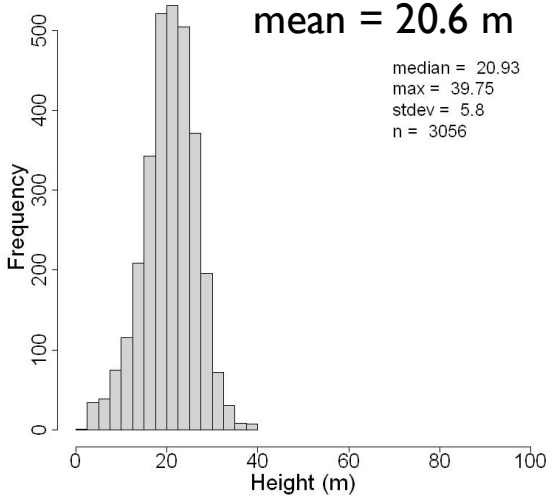




- **Simple random sampling**
- **Similar results when post-stratified by forest type group and ecological substrata**

FIA





8| Height – biomass allometry using FIA data

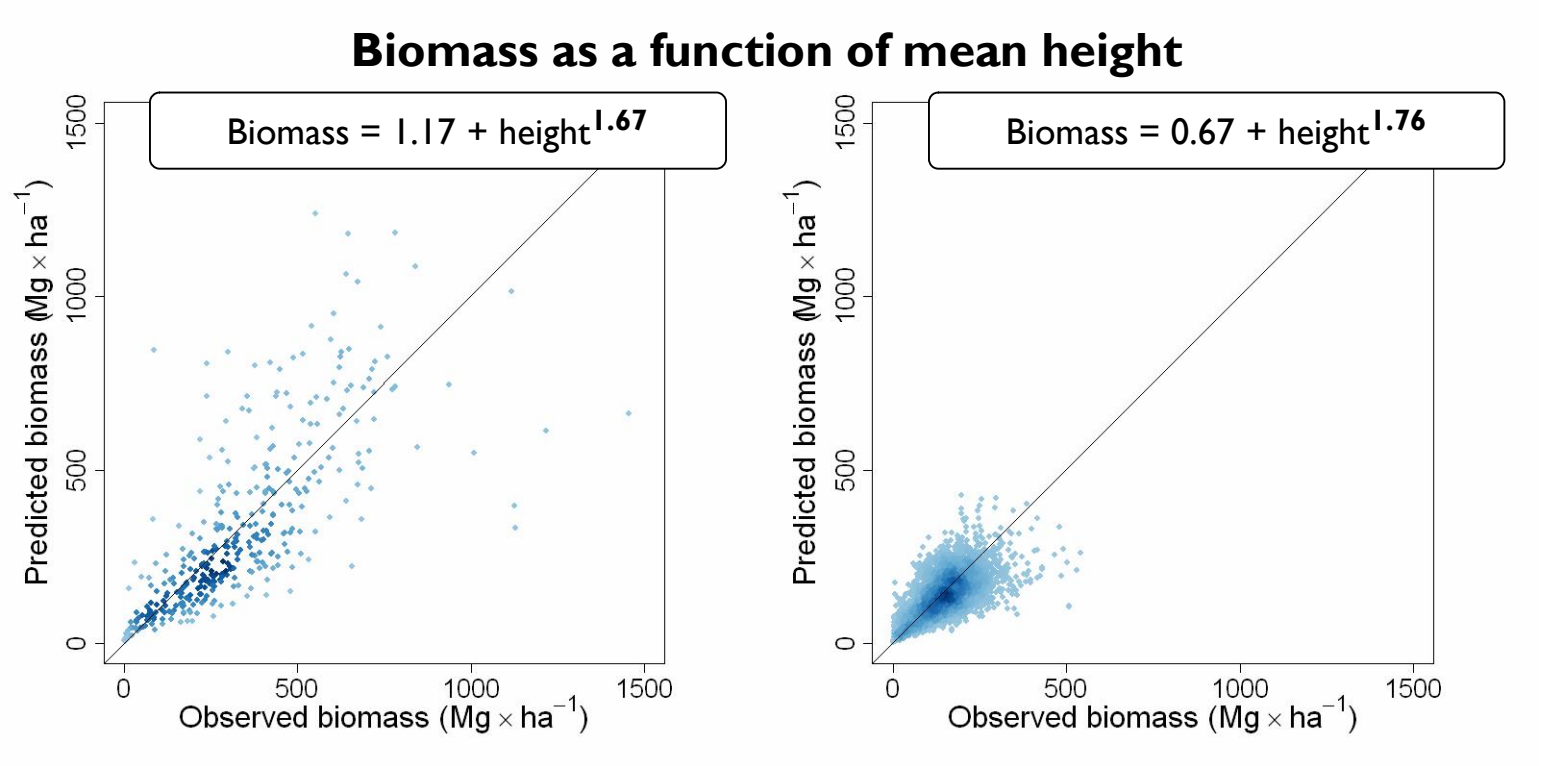
Cascades

Model	RMSE (Mg ha^{-1})	R^2
height + forest type & ecological region	169.82	0.76
height only	177.93	0.74

Appalachians

Model	RMSE (Mg ha^{-1})	R^2
height * forest type & ecological region	58.11	0.64
height only	60.76	0.59

Biomass as a function of mean height



| Conclusions & Outlook

1 Height estimation
- complicated in steep terrain
- allgorithm works best with mean height of dominant-codominanat trees
- regional 'bias' not related to forest type and ecological substrata

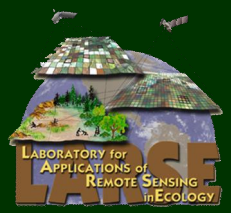
2 Height-biomass allometry
- Forest types and ecological subregions have little effect on the prediction accuracy of the regression models.
- Horizontal stand structure might be more important, and can be described with multi-spectral data.

3 Biomass estimation
- GLAS biomass estimates are lower then estimates from FIA in both study areas

4 Sampling
- Explore sampling strategies to improve estimate population totals and their variances.

5 Error propagation

Thank you!


Laboratory for Applications of Remote Sensing in Ecology
LARSE


OSU
Oregon State
University


Colorado
State
University


FOREST SERVICE
USFS
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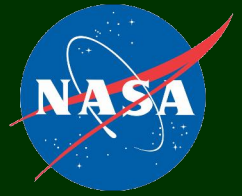
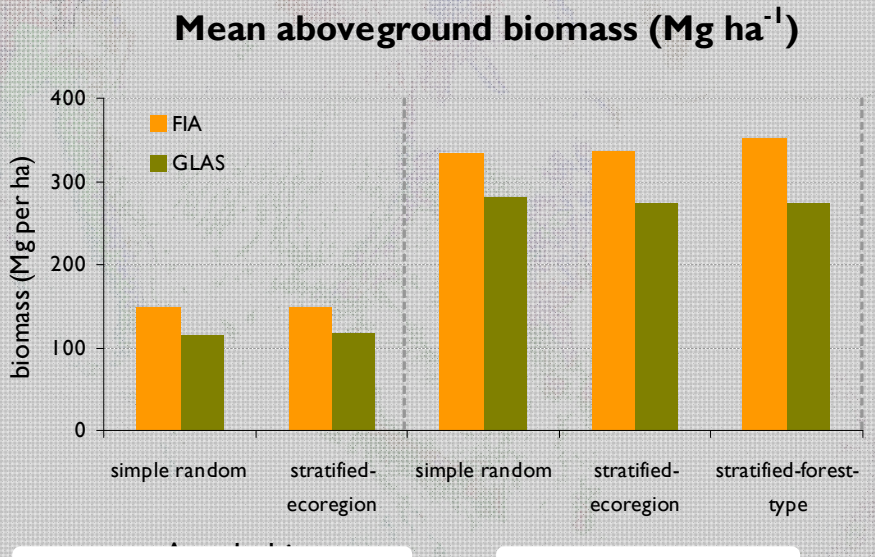

NASA


ICE, CLOUD, & LAND ELEVATION SATELLITE
ICESAT

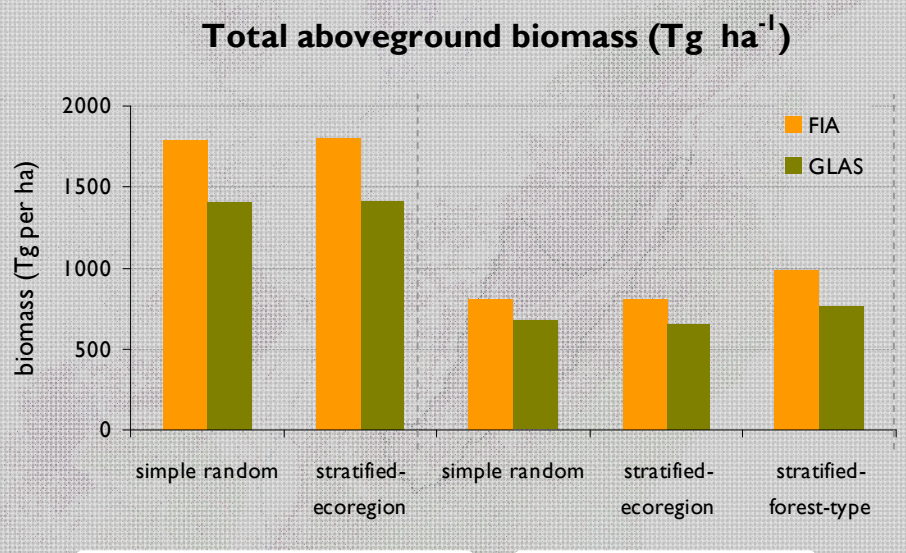
9| Mean and Total Biomass Estimates

FIA

GLAS



Appalachians **Cascades**



Appalachians **Cascades**